

IMPROVED LONG TERM DIMENSIONAL STABILITY OF PIGMENTED POLYMER
ARTICLES

5 The influence of pigments on undesired shrinkage or warpage of plastic articles is known and has been observed particularly for those products which have been pre-pared by injection molding. E.g. injection molded bottle crates in polypropylene or high density polyethylene may be dramatically affected by the use of pigments inducing warpage. Some pigments, known for their nucleation activity, were used e.g. for
10 differentiating extruded PBT tubes in optical fiber loose cables. Also, post-warpage appeared to depend on the type of pigment used. This warpage phenomenon is influenced e.g. by the processing parameters and mould temperatures using standard pigment concentrations of 0.1%. Another influencing factor is the size and form of the mold. The relative warpage is, in practice, determined by measurement of the dimen-
15 sions of the polymer sample comparing pigmented and unpigmented ("natural") samples of the same polymer prepared under the same conditions.

Warpage has been observed for a large variety of pigmented polymers and a great number of technical steps have been both reported and disclosed in view of reducing
20 this effect such as by employing reactive PMMA and methyl-methacrylate-vinyl acetate block copolymer types, poly(vinyl chloride-co-vinyl acetate) (VC-VAc), and poly(vinyl chloride-co-vinyl acetate-co- maleic anhydride) (VC-VAc-MA), of so called low profile additives (LPA) (see Huang, Yan-Jyi; Chen, Tzong-Shyang; Huang, Jyh-Gau; Lee, Fuh-Huah; Department of Chemical Engineering, National Taiwan University of Science
25 and Technology, Taipei 106, Taiwan. Abstr. Pap. - Am. Chem. Soc. (2000), 220th PMSE-321. CODEN: ACSRAL ISSN: 0065-7727) some with peroxide groups in their backbone, which could lead to expansion effects during cure. By employing LPA's, usually good volume shrinkage control and acceptable pigmentability for the molded parts were achieved. Other sources report the use of tailor made shrinkage reducing
30 additives (SRA) which is connected with additional technical efforts such as hardening the matrix.

For the achievement of an improved and simplified shrinkage control new concepts are desired which would constitute a progress for the state-of-the-art.

5 It has been observed that several pigments standardly used for the coloration of polymer matrices develop, by induction of artificial light and/or sunlight, i.e. during the lifetime of the article, some warpage effects which affect the dimensionnal properties of the end article. These effects occur for pigments known for providing warpage during processing, such as injection molding, as well as for pigments which are assessed as warpage free for the same processing.

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Surprisingly it has been found that pigments or combinations of several pigments with conventional polymer stabilizers which are frequently used for stabilization of the polymer matrix, lead to significant reduction of warpage effects which are induced by light, as described above. The polymer stabilizers are specific members of the class of
15 sterically hindered piperidine derivates / amines (HA(L)S) which are used alone or in various combinations with UV absorbers, processing stabilisers, phenol-type antioxidants and acid scavengers in pigmented polymers.

20 It is a major advantage of the method according to the invention, that the warpage induced by light can be controled with stabilizers beeing effective for improving the lightfastness and mechanical properties at the same time. Therefore no additional additive for warpage control has to be added.

25 Preferred combinations comprise 0.001% to 2.0% by weight of one or several pigments and 0.001% to 2.0% by weight of sterically hindered piperidine derivatives HA(L)S, based on the weight of the polymer.

30 As already mentioned above, the method at the same time provides for stabilization of the polymer in the sense of retarding chemical decomposition as well as it provides for effects which avoid undesired warpage induced by light. In particular, there is no necessity to incorporate additional components called "low-profile additives" (LPA) such as saturated polyester-based (SPE) or reactive poly(methyl methacrylate)

(PMMA), poly(vinyl acetate)-block-poly(methyl methacrylate) (PVAc-b-PMMA), red phosphorous or phosphates which specifically are dedicated to control warpage effects.

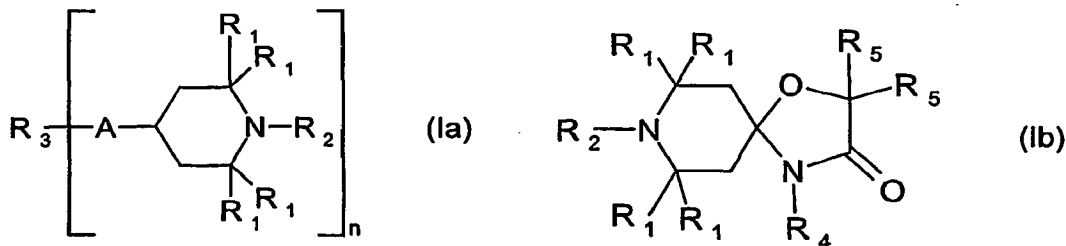
It has never before been described that warpage effects in pigmented polymers can be induced only under the influence of light rather than heat. It has never before been described either that sterically hindered piperidine derivatives (HA(L)S) can efficiently avoid deformation ("warpage") of pigmented polymer systems.

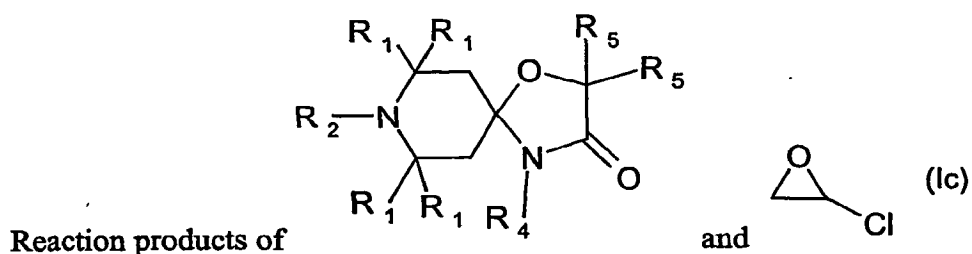
The object of the invention is, therefore, to provide a method for the reduction of warpage effects which are induced by light in pigmented polyolefins.

It has been found that a method comprising the steps of combining in the polyolefin polymer at least one organic pigment and at least one sterically hindered piperidine derivative (HA(L)S) as defined below reduces the warpage effect which is induced by light in polyolefin polymers.

Preferably, such sterically hindered piperidine derivatives (HA(L)S) are used in combination with UV absorbers, processing stabilisers, phenol-type antioxidants and acid scavengers (all as defined below) normally used for the purpose of improved lightfastness and improved mechanical properties.

The sterically hindered piperidine derivatives (HA(L)S) used in the method according to the invention, are the well known group of stabilizers already in use for the purpose of improved light-fastness and improved mechanical properties. Such sterically hindered piperidine derivatives are preferably of the formulae (Ia) – (Ic)

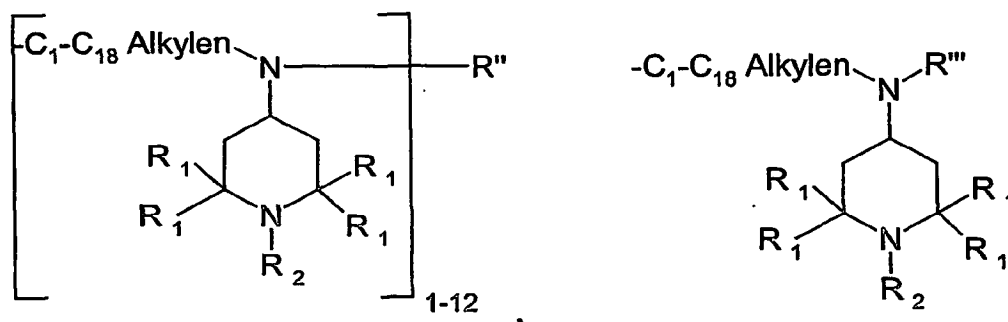




in which, independently of each other,

A is -O- or -NR',

5 R' H, C₁-C₁₈-alkyl or one of the groups



R'' H or C₁-C₁₈-alkyl,

10 R''' H, an aliphatic, cycloaliphatic, aromatic or heteroaromatic rest,

R₁ C₁-C₁₈-alkyl, or two R₁ bound to the common carbon atom represent a C₄-C₈-cycloalkyl rest,

R₂ H, C₁-C₁₈-alkyl or C₇-C₁₈-alkylaryl,

R₃ H, an aliphatic, cycloaliphatic, aromatic or heteroaromatic rest with n bounds,

15 R₄ C₁-C₁₈-alkyl or -C(O)-C₁-C₁₈-alkyl;

R₅ H, C₁-C₁₈-alkyl, C₄-C₁₈-cycloalkyl or two R₅ bound to the common carbon atom represent a C₄-C₈-cycloalkyl rest,

n is a integer > 0

20 Preferred hindered piperidine derivatives (HA(L)S) are 2,2,4,4-tetramethyl-7-oxa-3,20-diazadispiro[5.1.11.2]heneicosan-21-on (Hostavin[®] N20 available from Clariant), the reaction product of Hostavin[®] N 20 and epichlorhydrin (which together are Hostavin[®] N 30, available from Clariant), poly[[6-[(1,1,3,3-tetramethylbutyl)amino]-1,3,5-triazin-2,4-

diyl][(2,2,6,6-tetramethyl-4-piperidiny)imino]-1,6-hexandiyl-[(2,2,6,6-tetramethyl-4-piperidiny)imino]] (Chimassorb[®] 944 available from Ciba SC) as well as C₁₆₋₁₈ fatty acid ester of 2,2,6,6-tetramethyl-piperidinol (Hostavin[®] 845 available from Clariant), reaction products of 1,6-Hexandiamin, N, N'-bis(2,2,6,6-tetramethyl-4-piperidiny)-
5 polymer, 2,4,6-trichloro-1,3,5-triazine, N-butyl-1-butanamine and N-butyl-2,2,6,6-tetramethyl-4-piperidinamine (which together are Chimassorb[®] 2020 available from Ciba SC) and reaction products of N,N'-ethane-1,2-diylbis(1,3-propanediamine), cyclohexane, peroxidized 4-butylamino-2,2,6,6-tetramethylpiperidine and 2,4,6-trichloro-1,3,5-triazine (which together are Flamestab[®] NOR[™] 116 available from Ciba
10 SC).

The sterically hindered piperidine derivatives HA(L)S can be added in the method according to the invention as solids, in solution or melt as well as in the form of solid or liquid mixtures or masterbatches/concentrates. Preferably the sterically hindered
15 piperidine derivatives HA(L)S are added as solids or masterbatches/concentrates.

Preferably 0.001% to 2.0% by weight of one or several organic pigments and 0.001% to 2.0% by weight of sterically hindered piperidine derivatives HA(L)S, based on the weight of polymer, are combined in the method of the invention.

20 In a preferred embodiment, further additives (UV absorbers, processing stabilisers, phenol-type antioxidants and acid scavengers; all as defined below) independently are present each in an amount from 0.02 to 0.2 wt%, preferably each in an amount from 0.05 to 0.1 wt%.

25 As indicated above, the sterically hindered piperidine derivatives (HA(L)S) are used in pigmented polyolefine polymers in which the warpage effects are observed. Such polymers are polymers of monoolefins and diolefins, for example polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyisoprene or polybutadiene, as
30 well as polymers of cycloolefins, for example of cyclopentene or norbornene; furthermore polyethylene (which optionally can be crosslinked); for example, high density polyethylene (HDPE), polyethylene of high density and high molar mass (HDPE-HMW), polyethylene of high density and ultrahigh molar mass (HDPE-UHMW),

medium density polyethylene (HMDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), branched low density polyethylene (BLDPE).

1. Polyolefins, i.e. polymers of monoolefins as exemplified in the preceding paragraph, in particular polyethylene and polypropylene, can be prepared by various, and especially by the following, methods:
 - a) free-radical polymerization (normally under high pressure and at elevated temperature)
 - b) catalytic polymerization using a catalyst that normally contains one or more metals of group IVb, Vb, VIb or VIII of the Periodic Table. These metals usually have one or more ligands, such as oxides, halides, alcoholates, esters, ethers, amines, alkyls, alkenyls and/or aryls that may be either π - or σ -coordinated. These metal complexes may be in the free form or fixed on substrates, for example on activated magnesium chloride, titanium(III) chloride, alumina or silicon oxide. These catalysts may be soluble or insoluble in the polymerization medium. The catalysts can be active as such in the polymerization or further activators may be used, for example metal alkyls, metal hydrides, metal alkyl halides, metal alkyl oxides or metal alkyloxanes, the metals being elements of groups Ia, IIa and/or IIIa of the Periodic Table. The activators may be modified, for example, with further ester, ether, amine or silyl ether groups. These catalyst systems are usually termed Phillips, Standard Oil Indiana, Ziegler (-Natta), TNZ (DuPont), metallocene or single site catalysts (SSC).
2. Mixtures of the polymers mentioned under 1), for example mixtures of polypropylene with polyisobutylene, polyethylene with polyisobutylene, polypropylene with polyethylene (for example PP/HDPE/LDPE) and mixtures of different types of polyethylene (for example LDPE/HDPE) with one another.

Copolymers of monoolefins and diolefins with each other or with other vinyl monomers, for example ethylene-propylene copolymers, linear low density polyethylene (LLDPE) and mixtures thereof with low density polyethylene (LDPE),

propylene-but-1-ene co-polymers, propylene-isobutylene copolymers, ethylene-but-1-ene copolymers, ethylene-hexene copolymers, ethylene-methylpentene copolymers, ethylene-heptene copolymers, ethylene-octene copolymers, propylene-butadiene copolymers, iso-butylene-isoprene copolymers, ethylene-alkyl acrylate copolymers, 5 ethylene-alkyl methacrylate copolymers, ethylene-vinyl acetate copolymers and their copolymers with carbon monoxide or ethylene-acrylic acid copolymers and their salts (ionomers) as well as terpolymers of ethylene with propylene and a diene such as hexadiene, dicyclo-pentadiene or ethylidene-norbornene; and mixtures of such copolymers with one another and with polymers mentioned under 1), for example 10 polypropylene-ethylene-propylene copolymers, LDPE-ethylene-vinyl acetate copolymers, LDPE-ethylene-acrylic acid copolymers, LLDPE-ethylene-vinyl acetate copolymers, LLDPE-ethylene-acrylic acid copolymers and alternating or random polyalkylene-carbon monoxide copolymers and mixtures thereof with other polymers, for example polyamides.

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In these polymers, further additives may be present, for example:

1. Antioxidants

20 1.1 Alkylated monophenols, for example 2,6-di-tert-butyl-4-methylphenol, 2-butyl-4,6-dimethylphenol, 2,6-di-tert-butyl-4-ethylphenol, 2,6-di-tert-butyl-4-n-butylphenol, 2,6-di-tert-butyl-4-isobutylphenol, 2,6-dicyclopentyl-4-methylphenol, 2,4a-methyl-cyclohexyl-4,6-dimethylphenol, 2,6-dioctadecyl-4-methylphenol, 2,4,6-tricyclo-hexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol, 2,6-dinonyl-4-methyl-phenol, 2,4-dimethyl-6-(1'-methylundec- 25 1'-yl) phenol, 2,4-dimethyl-6-(1'-methyl-heptadecyl)phenol, 2,4-dimethyl-6-(1'-methyltridec-1'-yl)phenol and mixtures thereof.

30 1.2 Alkylthiomethylphenols, for example 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-di-dodecyl-thiomethyl-4-nonylphenol.

- 1.3 Hydroquinones and alkylated hydroquinones, for example 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-di-phenyl-4-octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxy-anisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxy-phenyl stearate, bis(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.
- 1.4 Tocopherols, for example α -tocopherol, β -tocopherol, γ -tocopherol, δ -tocopherol and mixtures thereof (vitamin E).
- 1.5 Hydroxylated thiodiphenyl ethers, for example 2,2'-thio-bis-(6-tert-butyl-4-methyl-phenol), 2,2'-thiobis(4-octylphenol), 4,4'-thiobis(6-tert-butyl-3-methylphenol), 4,4'-thiobis(6-tert-butyl-2-methylphenol), 4,4'-thiobis(3,6-di-sec-amylphenol), 4,4'-bis-(2,6-dimethyl-4-hydroxyphenyl) disulphic.
- 1.6 Alkylidenebisphenols, for example 2,2'-methylenebis(6-tert-butyl-4-methyl-phenol), 2,2'-methylenebis(6-tert-butyl-4-ethylphenol), 2,2'-methylenebis[4-methyl-6-(α -methyl-cyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexyl-phenol), 2,2'-methylene-bis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidene-bis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol), 2,2'-methylenebis[6-(α -methylbenzyl)-4-nonyl-phenol], 2,2'-methylenebis[6-(α,α -dimethylbenzyl)-4-nonylphenol], 4,4'-methyl-enebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-1-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecyl-mercaptobutane, ethylene glycol bis[3,3-bis'(3'-tert-butyl-4'-hydroxyphenyl)buty-rate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis(3,5-di-methyl-2-hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxy-phenyl)propane, 2,2-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecyl-mercaptobutane, 1,1,5,5-tetra-(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.

- 1.7 O-, N- and S-benzyl compounds, for example 3,5,3',5'-tetra-tert-butyl-4,4'-di-hydroxydibenzyl ether, octadecyl 4-hydroxy-3,5-dimethylbenzyl mercaptoacetate, tris(3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethyl-benzyl) dithioterephthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl) sulphide, isooctyl 3,5-di-tert-butyl-4-hydroxybenzyl mercaptoacetate.
- 1.8 Hydroxybenzylated malonates, for example dioctadecyl 2,2-bis(3,5-di-tert-butyl-2-hydroxybenzyl)malonate, dioctadecyl 2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)-malonate, didodecyl mercaptoethyl-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-malonate, di[4-(1,1,3,3-tetramethylbutyl)phenyl], 2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate.
- 1.9 Aromatic hydroxybenzyl compounds, for example 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzol, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-phenol.
- 1.10 Triazine compounds, for example 2,4-bis-octylmercapto-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxy-anilino)-1,3,5-triazine, 2-octyl-mercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxy-phenoxy)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,2,3-tri-azine, 1,3,5-tris-(3,5-di-tert-butyl-4-hydroxybenzyl) isocyanurate, 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl) isocyanurate, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenyl-propionyl)hexahydro-1,3,5-triazine, 1,3,5-tris(3,5-dicyclohexyl-4-hydroxybenzyl) isocyanurate.
- 1.11 Benzylphosphonates, for example dimethyl 2,5-di-tert-butyl-4-hydroxybenzyl-phosphonate, diethyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl 3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl 5-tert-butyl-4-hydroxy-3-methyl-benzylphosphonate, the Ca salt of the monoethyl ester of 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid.

- 1.12 Acylaminophenols, 4-hydroxylauramide, 4-hydroxystearanilide, octyl N-(3,5-di-
tert-butyl-4-hydroxyphenyl)carbamate.
- 1.13 Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or poly-
5 hydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexane-
diol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodi-
ethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol,
tris(hydroxy-ethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-
thiaundecanol, 3-thia-pentadecanol, trimethyl-hexanediol, trimethylolpropane, 4-
10 hydroxymethyl-1-phospha-2,6,7-trioxabicyclo-[2.2.2]octane.
- 1.14 Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or
polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-
hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol,
15 thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris-
(hydroxyethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3-thiaundecanol,
3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-
phospha-2,6,7-trioxabi-cyclo[2.2.2]octane.
- 20 1.15 Esters of β -(3,5-dicyclohexyl-4-hydroxy-phenyl)propionic acid with mono- or
poly-hydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-
hexane-diol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol,
thiodi-ethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol,
tris(hydroxy-ethyl) isocyanurate, N,N'-bis(hydroxyethyl)oxalamide, 3
25 thiaundecanol, 3-thia-pentadecanol, trimethyl-hexanediol, trimethylolpropane, 4-
hydroxymethyl-1-phospha-2,6,7-trioxabicyclo-[2.2.2]octane.
- 1.16 Esters of 3,5-di-tert-butyl-4-hydroxyphenylacetic acid with mono- or polyhydric
alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-
30 nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene
glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)
isocyanurate, N,N-bis-(hydroxyethyl)oxalamide, 3-thia-undecanol, 3-thiapenta-

decanol, trimethyl-hexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospho-2,6,7-trioxabicyclo-[2.2.2]octane.

- 1.17 Amides of β -(3,5-di-tert-butyl-4-hydroxy-phenyl)propionic acid,
 5 e.g. N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamine,
 N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamine,
 N,N'-bis(3,5-di-tert-butyl-4-hydroxy-phenylpropionyl)hydrazine.
- 1.18 Substituted benzofuranone compounds for example mixtures of 5,7-di-tert-butyl-3-
 10 (3,4-dimethylphenyl)-3H-benzofuran-2-one and 5,7-di-tert-butyl-3-(2,3-
 dimethylphenyl)-3H-benzofuran-2-one.
2. UV absorbers and light stabilizers
- 15 2.1 2-(2'-Hydroxyphenyl)benzotriazoles, for example 2-(2'-hydroxy-5'-
 methylphenyl)-benzotriazole, 2-(3',5'-di-tert-butyl-2'-
 hydroxyphenyl)benzotriazole. 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-
 (2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)-phenyl)benzo-triazole, 2-(3',5'-di-tert-
 butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3-tert-butyl-2'-hydroxy-5'-
 20 methylphenyl)-5-chlorobenzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxy-
 phenyl)benzotriazole, 2-(2'-hydroxy-4'-octoxy-phenyl)benzotriazole, 2-(3',5'-di-
 tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis(α,α -dimethylbenzyl-2'-
 hydroxyphenyl)-benzotriazole, a mixture of 2-(3'-tert-butyl-2'-hydroxy-5'-(2-
 octyloxycarbonyl-ethyl)-phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-5'-[2-(2-
 25 ethylhexyloxy)carbonyl-ethyl]-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-
 tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl-ethyl)phenyl)-5-chlorobenzotriazole,
 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl-ethyl)-phenyl)benzotriazole, 2-
 (3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl-ethyl)-phenyl)benzotriazole, 2-(3'-
 30 tert-butyl-5'-[2-(2-ethylhexyloxy)carbonyl-ethyl]-2'-hydroxy-phenyl)benzotriazole,
 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzo-triazole and 2-(3'-tert-butyl-2'-
 hydroxy-5'-(2-isooctyloxycarbonyl-ethyl)phenyl)-benzotriazole, 2,2'-methylene-
 bis[4(1,1,3,3-tetramethylbutyl)-6-benzotriazol-2-ylphenol]; the transesterification
 product of 2-[3-tert-butyl-5'-(2-methoxycarbonyl-ethyl)-2'-hydroxy-

phenyl]benzotriazole with polyethylene glycol 300, $[R-CH_2CH_2-COO(CH_2)_3]_2$ where R = 3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-yl-phenyl.

- 2.2 2-Hydroxybenzophenones, for example the 4-hydroxy, 4-methoxy, 4-octoxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy and 2'-hydroxy-4,4'-dimethoxy derivative.
- 2.3 Esters of substituted or unsubstituted benzoic acids, for example 4-tert-butylphenyl salicylate, phenyl salicylate, octylphenyl salicylate, dibenzoylresorcinol, bis(4-tert-butylbenzoyl)resorcinol, benzoylresorcinol, 2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, hexadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, octadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-methyl-4,6-di-tert-butyl-phenyl 3,5-di-tert-butyl-4-hydroxy-benzoate.
- 2.4 Acrylates, for example ethyl α -cyano- β,β -diphenylacrylate or isooctyl α -cyano- β,β -diphenylacrylate, methyl α -carbomethoxycinnamate, methyl α -cyano- β -methyl-p-methoxycinnamate or butyl α -cyano- β -methyl-p-methoxycinnamate, methyl α -carbo-methoxy-p-methoxycinnamate and N-(β -carbomethoxy- β -cyano-vinyl)-2-methylindoline.
- 2.5 Nickel compounds, for example nickel complexes of 2,2'-thio-bis-[4-(1,1,3,3-tetramethylbutyl)phenol], such as the 1:1 or 1:2 complex, with or without additional ligands such as n-butylamine, triethanolamine or N-cyclohexyldiethanolamine, nickel dibutyldithiocarbamate, nickel salts of monoalkyl esters, such as of the methyl or ethyl ester, of 4-hydroxy-3,5-di-tert-butylbenzylphosphonic acid, nickel complexes of ketoximes, e.g. of 2-hydroxy-4-methylphenyl undecyl ketoxime, nickel complexes of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands.
- 2.6 Oxalamides, for example 4,4'-dioctyloxyoxanilide, 2,2'-diethoxyoxanilide, 2,2'-dioctyloxy-5,5'-di-tert-butylloxanilide, 2,2'-didodecyloxy-5,5'-di-tert-butylloxanilide, 2-ethoxy-2'-ethyloxanilide, N,N'-bis(3-dimethylaminopropyl)-oxalamide, 2-ethoxy-5-tert-butyl-2'-ethyloxanilide and its mixture with 2-ethoxy-

2'-ethyl-5,4'-di-tert-butyloxanilide and mixtures of o- and p-methoxy-disubstituted and of o- and p-ethoxy-disubstituted oxanilides.

- 2.7 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-octyloxy-phenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethyl-phenyl)-1,3,5-triazine, 2-(2,4-dihydroxy-phenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxypropyloxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxypropyloxy)phenyl]-4,6-bis-(2,4-dimethylphenyl)-1,3,5-triazine.
3. Metal deactivators, for example, N,N'-diphenyloxalamide, N-salicylal-N'-salicyloyl-hydrazine, N,N'-bis(salicyloyl)hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxy-phenylpropionyl)hydrazine, 3-salicyl-oylamino-1,2,4-triazole, bis(benzylidene)-oxalyl dihydrazide, oxanilide, isophthaloyl dihydrazide, sebacoyl bisphenyl-hydrazide, N,N'-diacetyladipoyl dihydrazide, N,N'-bis(salicyloyl)oxalyl dihydrazide, N,N'-bis(salicyloyl)thiopropionyl dihydrazide.
4. Phosphites and phosphonites, for example triphenyl phosphite, diphenyl alkyl phosphites, phenyl dialkyl phosphites, tris(nonylphenyl) phosphite, trilauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butyl-phenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl) pentaerythritol diphosphite, bis(2,6-di-tert-butyl-4-methylphenyl) pentaerythritol diphosphite, bisisodecyloxy pentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl) pentaerythritol diphosphite, bis(2,4,6-tri-tert-butyl-phenyl) pentaerythritol diphosphite, tristearyl sorbitol triphosphite, tetrakis(2,4-di-tert-butylphenyl) 4,4'-biphenylenediphosphonite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-12H-dibenzo[d,g]-1,3,2-dioxaphosphocin, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenzo[d,g]-1,3,2-dioxaphosphocin, bis(2,4-di-tert-butyl-6-methylphenyl) methyl phosphite, bis(2,4-di-tert-butyl-6-methylphenyl) ethyl phosphite.

5. Peroxide scavengers, examples being esters of β -thiodipropionic acid, for example the lauryl, stearyl, myristyl or tridecyl ester, mecaptobenzimidazole, the zinc salt of 2-mercaptobenzimidazole, zinc dibutyldithiocarbamate, dioctadecyl disulphide, pentaerythritol tetrakis(β -dodecylmercapto)propionate.
6. Polyamide stabilizers, examples being copper salts in combination with iodides and/or phosphorus compounds and salts of divalent manganese.
7. Basic costabilizers, examples being melamin, polyvinylpyrrolidone, dicyandi-
amide, triallyl cyanurate, urea derivatives, hydrazine derivatives, amines, poly-
amides, polyurethanes, alkali metal salts and alkaline earth metal salts of higher
fatty acids, for example Ca stearate, Zn stearate, Mg behenate, Mg stearate, Na
ricinoleate, K palmitate, antimony pyrocatecholate or tin pyrocatecholate. Alkali
metal salts and alkaline earth metal salts of lactates for example Ca lactate.
8. Nucleating agents, such as benzoic acid, 4-tert-butylbenzoic acid, adipic acid;
diphenylacetic acid and their salts, phosphates, phosphonates and phosphinates
and their esters and salts or clarifiers, such as derivatives of di-benzylidene
sorbitol.
9. Fillers and reinforcing agents, examples being calcium carbonate, silicates, glass
fibers, asbestos, talc, kaolin, mica, barium sulphate, metal oxides and hydro-xides,
carbon black, graphite.
10. Other additives, examples being plasticizers, lubricants, emulsifiers, pigments,
optical brighteners, flameproofing agents, antistatics, blowing agents.

Any additional additives can be added to the polyolefines before, together with or after
addition of the HA(L)S compounds according to the method of the invention. The
additional additives can be added as solids, in solution or melt as well as in the form of
solid or liquid mixtures or masterbatches/concentrates.

- Preferred UV absorbers are 2-hydroxybenzophenones, particularly 4-hydroxy, 4-methoxy, 4-octoxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy and 2'-hydroxy-4,4'-di-methoxy derivative, 2-(2'-hydroxyphenyl)-benzotriazoles, especially 2-(2'-hydroxy-5'-methylphenyl)-benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-[2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)-phenyl]benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chlorobenzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octoxyphenyl)-benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)-benzotriazole, 2-(3',5'-bis-(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, a mixture of 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, and 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonylethyl)phenyl)benzotriazole, 2,2'-methylenebis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazol-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonylethyl)-2'-hydroxyphenyl]benzotriazole with polyethylene glycol 300; $[R-CH_2CH_2-COO-(CH_2)_3]_2$ where R = 3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-yl-phenyl.
- Preferred processing stabilizers are organophosphite or organophosphonite stabiliser, most preferably tris(2,4-di-tert-butylphenyl)phosphite (available from Clariant as Hostanox® PAR 24) or tetrakis-(2,4-di-tert-butylphenyl)-biphenylene-diphosphonite (available from Clariant as Sandostab® P-EPQ).
- Preferred phenol-type antioxidants are tetrakismethylene(3,5-di-tert-butyl-4-hydroxyphenyl)-hydrocinnamate (available from Clariant as Hostanox® O10).

Preferred acid scavengers are metal stearates, most preferably zinc stearate or calcium stearate.

5 The warpage effects to be avoided can be observed with all kinds of pigments used for the coloration of polymers. Such effects are, however, most embarrassing with industrial organic pigments based on azo pigments, quinacridones, phthalocyanines, indanthrones, flavanthrones, pyranthrones, anthraquinones, perylenes, perinones, dioxazines, thioindigo pigments, isoindolines, isoindolinones, organic metal complexes as well as inorganic pigments.

10

A comprehensive description of those organic pigments is given for example in the book titled "Industrial Organic Pigments", authors W.Herbst and K.Hunger, 2nd revised ed., publisher VCH, Weinheim, Germany (1997).

15 The preferred organic pigments used in combination with the sterically hindered piperidine derivatives HA(L)S are those specified in the examples.

The invention will now be illustrated by examples:

20

EXAMPLES

General description of sample preparation, exposure and evaluation of results.

25 PE-HD is stabilised with a standard base process stabilisation comprising 0.10% of an organophosphite or alternatively organophosphonite stabiliser (like tris(2,4-di-tert.-butylphenyl)phosphite, Hostanox[®] PAR 24 or alternatively tetrakis-(2,4-di-tert.-butylphenyl)-biphenylene-diphosphonite, Sandostab[®] P-EPQ, both available from Clariant), 0.05% of a metal stearate (like zinc stearate or calcium stearate) and 0.05% of
30 a phenolic antioxidant (like tetrakismethylene(3,5-di-tert.butyl-4-hydroxyphenyl)-hydrocinnamate, Hostanox[®] O10 available from Clariant).

The pigment concentration in the final plaques is 0.1%. The following three different organic pigments have been tested: Pigment Red 48:3, Pigment Yellow 180 and Pigment Yellow 155.

- 5 The HA(L)S concentration in the final plaques is 0.2%. Several commercial HA(L)S derivatives have been tested such as Hostavin[®] N30 (available from Clariant), Chimassorb[®] 944 (available from Ciba SC), Chimassorb[®] 2020 (available from Ciba SC), Flamestab[®] NOR[™] 116 (available from Ciba SC) and Hostavin[®] 845 (available from Clariant).

10

Hostavin[®] N 30, available from Clariant is the reaction product of 2,2,4,4-tetramethyl-7-oxa-3,20-diazadispiro[5.1.11.2]heneicosan-21-on (Hostavin[®] N20 available from Clariant) and epichlorhydrin;

15

Hostavin[®] 845 available from Clariant is C₁₆₋₁₈ fatty acid ester of 2,2,6,6-tetramethyl-piperidinol;

Chimassorb[®] 944 available from Ciba SC is poly[[6-[(1,1,3,3-tetramethylbutyl)amino]-1,3,5-triazin-2,4-diyl][(2,2,6,6-tetramethyl-4-piperidiny)imino]-1,6-hexandiyl-[(2,2,6,6-tetramethyl-4-piperidiny)imino]];

20

Chimassorb[®] 2020 available from Ciba SC is a reaction product of 1,6-Hexandiamin, N, N'-bis(2,2,6,6-tetramethyl-4-piperidiny)-polymer, 2,4,6-trichloro-1,3,5-triazine, N-butyl-1-butanamine and N-butyl-2,2,6,6-tetramethyl-4-piperidinamine;

25

Flamestab[®] NOR[™] 116 available from Ciba SC is a reaction product of N,N'-ethane-1,2-diylbis(1,3-propanediamine), cyclohexane, peroxidized 4-butylamino-2,2,6,6-tetramethylpiperidine and 2,4,6-trichloro-1,3,5-triazine.

30

The PE-HD plaques (thickness 1 mm) are prepared either by means of a heat press or by injection moulding.

Exposure of the plaques takes place alternatively by:

Weather-O-Meter (according to ISO 11341-C): light continuous, dry conditions, radiation energy 0.47 W/mm^2 , black panel temperature 63°C , relative humidity 50%, radiation filter 340 nm.

- 5 UV-A (according to DIN 5208-91-A with a black panel temperature of 63°C) : light continuous, dry conditions, relative humidity 50%, radiation filter 340 nm.

In order to evaluate the warpage of the plaques, the following method is used:

- 10 All initial PE-HD plaques (geometries: 50 mm length x 50 mm width x 1 mm thickness) are completely flat. After ageing by artificial exposure, it has been observed that the plaques are not anymore flat but deformed : the 1 mm injection moulded plaques warp especially in the normal (vertical) direction; the samples get a 3D shape due to the deformation. By measuring the sample projecting the final contour in a plane, it results
15 for example that the length is still 50 mm but the width now is 48.5 mm, as shown in Figure 1.

A good indication of this kind of warpage can be assessed by measuring the height taking place in the normal direction.

20

Three parameters have been evaluated :

- the length shift in percent compared to non exposed plaque (error = 0.2%).
- the width shift in percent compared to non exposed plaque (error = 0.2%).
- the height in mm compared to non exposed plaque (error = 0.5 mm).

- 25 Three parameters have been evaluated :

- the length shift in percent compared to non exposed plaque (error = 0.2%).
- the width shift in percent compared to non exposed plaque (error = 0.2%).
- the height in mm compared to non exposed plaque (error = 0.5 mm).

30 **EXAMPLE 1**

Three different commercial pigments have been tested in a PE-HD matrix (type Eltex, producer Solvay).

All pressed plaques (thickness 1mm) have been exposed 1500 hours by means of UV-A exposure. Before exposure, no warpage is observed for any formulation.

At the end of exposure the height, width and length are measured. The corresponding data are presented in table 1.

TABLE 1

Dimensional deformation after UVA exposure of pigmented HDPE matrix

exposure time (hours)	0 h	1500 h	1500 h	1500 h
Pigment type	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	0	0,5	0,9
Pigment Yellow 155	0	2	0,9	0,7
Pigment Yellow 180	0	2	1,2	0,7
Pigment Red 48:3	0	2	1,4	0,5

All 3 pigmented plaques lead to warpage to a similar extent after 1500 hours of UV-A light exposure; only the non pigmented matrix remains flat.

EXAMPLE 2

The same pigments as used in example 1 have been used and tested in another PE-HD matrix (type Hostalen; producer Basell).

After preparing these plaques (thickness 1mm) by heat pressing, exposure during 1500 hours by UV-A took place. Before exposure, no warpage was observed for any formulation. At the end, the height, width and length are measured (see table 2).

TABLE 2

Dimensional deformation after UVA exposure of pigmented HDPE matrix

exposure time (hours)	0 h	1500 h	1500 h	1500 h
Pigment	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	0	0,7	0,9
Pigment Yellow 155	0	2,5	1,6	0,8
Pigment Yellow 180	0	2,5	1,7	0,9
Pigment Red 48:3	0	2,5	1,8	0,7

5

Warpage is observed for all three pigmented PE-HD plaques.

EXAMPLE 3

10

Pigment Red 48:3 has been tested in a PE-HD matrix (type Rigidex, producer BP Chemicals) without any and together with different types of sterically hindered piperidine derivatives HA(L)S.

- 15 All 1 mm injection moulded plaques (thickness each 1mm) are exposed during 2000 hours in a Weather-O-meter. The results are presented in table 3.

TABLE 3

Dimensional deformation ("warpage") of some pigmented PE-HD samples containing various HA(L)S derivatives after Weather-O-meter exposure.

20

exposure time (hours)	0 h	2000 h	2000 h	2000 h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	0	0,7	0,2
Red 48:3 + no HALS	0	2	1,9	0,5
Red 48:3 + Hostavin [®] N 30	0	0	0,3	0,3
Red 48:3 + Chimassorb [®] 944	0	0	0,3	0,2
Red 48:3 + Chimassorb [®] 2020	0	0	0,4	0,1
Red 48:3 + Flamestab [®] NOR [™] 116	0	0	0,3	0,2
Red 48:3 + Hostavin [®] 845	0	0	0,4	0,1

The warpage effect is prevented with several HA(L)S after 2000 hours of artificial light exposure. Only the pigmented matrix without HA(L)S leads to warpage after 2000 hours of artificial light exposure.

5

EXAMPLE 4

Pigment Yellow 180 has been tested in a PE-HD matrix (type Hostalen, producer Basell) without any and together with a sterically hindered piperidine derivative
10 HA(L)S.

Heat pressed plaques (thickness 1mm) are exposed during 1200 hours in a Weather-o-meter. Results are shown in table 4.

15 **TABLE 4**

Dimensional deformation after WOM exposure of pigmented HDPE matrix.

exposure time (hours)	0 h	1200 h	1200 h	1200 h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	0	0,9	0,8
Yellow 180	0	1,5	1,3	0,8
Yellow 180 + Hostavin® N 30	0	0	0,8	0,8

20 After 1200 hours of artificial light exposure, the warpage effect is clearly prevented using Hostavin® N 30.

EXAMPLE 5

25 Pigment Yellow 180 has been tested in a PE-HD matrix (type Hostalen, producer Basell), without any and together with a sterically hindered piperidine derivative HA(L)S.

Heat pressed plaques (thickness 1mm) are exposed during 1450 hours by UV-A exposure. The results are shown in table 5.

TABLE 5

Dimensional deformation after UV-A exposure of pigmented PE-HD matrix.

exposure time (hours)	0 h	1450 h	1450 h	1450 h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	0	1,1	1,1
Yellow 180	0	2,5	1,9	1,2
Yellow 180 + Hostavin [®] N 30	0	0	0,9	0,8

5

As demonstrated in this example, the warpage effect is prevented using Hostavin[®] N 30 after 1450 hours of UV-A light exposure.

EXAMPLE 6 - 9

10

The dimensional values given in the following examples are calculated via a more precise measurement method. The precision of the measurement is for example 0.76% width shift +/- 0.03%.

15 **EXAMPLE 6**

The pigment Yellow 155 has been tested in a HDPE matrix (HOSTALEN from BASSELL) without any and together with different types of sterically hindered piperidine derivatives HA(L)S.

20 The 2 mm pressed plates have been exposed 1250 hours in UV-A exposure.

TABLE 6

Dimensional deformation after UV-A exposure of pigmented HDPE matrix.

exposure time (hours)	0h	1250h	1250h	1250h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	-0.17	0.76	0.47
Yellow 155	0	1.56	0.55	0.73
Yellow 155 + Hostavin N30	0	0.23	0.34	0.37
Yellow 155 + Chimassorb 944	0	0.16	0.39	0.37
Yellow 155 + Chimassorb 2020	0	0.11	0.35	0.36
Yellow 155 + Hostavin 845	0	-0.40	0.24	0.34

25

Again, the warpage effect is prevented with HALS after 1250 hours in UVA exposure. Only the pigmented matrix without HALS shows warpage after 1250 hours of UVA exposure.

5

EXAMPLE 7

The pigment Yellow 155 has been tested in a HDPE matrix (HOSTALEN from BASSELL) without any and together with different types of sterically hindered piperidine derivatives HA(L)S.

10

The 2 mm pressed plates have been exposed 2500 hours in Weather-Ometer exposure.

TABLE 7

Dimensional deformation after Weather-Ometer exposure of pigmented HDPE matrix.

15

exposure time (hours)	0h	2500h	2500h	2500h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	-0,09	0,58	0,36
Yellow 155	0	2,02	0,58	0,73
Yellow 155 + Hostavin N30	0	0,34	0,31	0,34
Yellow 155 + Chimassorb 944	0	0,24	0,31	0,32
Yellow 155 + Chimassorb 2020	0	0,24	0,28	0,29
Yellow 155 + Hostavin 845	0	-0,28	0,25	0,34

Again, the warpage effect is prevented with HALS after 2500 hours in WOM exposure. Only the pigmented matrix without HALS shows warpage after 2500 hours of WOM exposure.

20

EXAMPLE 8

The pigment Yellow 155 has been tested in a HDPE matrix (RIGIDEX from BP Chemicals) without any and together with different types of sterically hindered piperidine derivatives HA(L)S.

25

The 2 mm pressed plates have been exposed 1250 hours in UVA exposure.

TABLE 8

Dimensional deformation after UVA exposure of pigmented HDPE matrix.

exposure time (hours)	0h	1250h	1250h	1250h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	0,17	0,67	0,50
Yellow 155	0	1,63	0,56	0,43
Yellow 155 + Hostavin N30	0	-0,07	0,34	0,38
Yellow 155 + Chimassorb 944	0	0,2	0,34	0,38
Yellow 155 + Chimassorb 2020	0	0,21	0,36	0,36
Yellow 155 + Hostavin 845	0	0,29	0,35	0,33

5

Again, the warpage effect is prevented with HALS after 1250 hours in UVA exposure. Only the pigmented matrix without HALS shows warpage after 1250 hours of UVA exposure.

10

EXAMPLE 9

The pigment Yellow 155 has been tested in a HDPE matrix (RIGIDEX from BP Chemicals) without any and together with different types of sterically hindered piperidine derivatives HA(L)S.

15

The 2 mm pressed plates have been exposed 2500 hours in Weather-Ometer exposure.

TABLE 9

20 Dimensional deformation after Weather-Ometer exposure of pigmented HDPE matrix.

exposure time (hours)	0h	2500h	2500h	2500h
Formulation	height (mm)	height (mm)	width shift (%)	length shift (%)
no pigment	0	-0,13	0,74	0,41
Yellow 155	0	2,44	0,89	0,54
Yellow 155 + Hostavin N30	0	0,08	0,38	0,42
Yellow 155 + Chimassorb 944	0	0,37	0,36	0,39
Yellow 155 + Chimassorb 2020	0	0,41	0,40	0,40
Yellow 155 + Hostavin 845	0	-0,27	0,37	0,36

Again, the warpage effect is prevented with HALS after 2500 hours in WOM exposure. Only the pigmented matrix without HALS shows warpage after 2500 hours of WOM exposure.